Anthropic pressures on Nature 2000 Sites:
recommendations and monitoring criteria for the pollution emergency response activities within the Orbetello lagoon

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Natura 2000 network and transitional environments

Natura 2000 is a network of sites (called SACs and SPAs) characterised by the presence of habitats and species of community interest. The legal framework is provided by the European directives "Habitats" 92/43/EC and "Birds" 79/409/EC. Natura 2000 is aimed at ensuring the maintainance or restoration of habitats and species that are rare or threatened, and at ensuring that the conservation of biodiversity is integrated to the requirements of socio-economic sustainable development at the Paneuropean level. The innovative approach of these directives is that they keep into account also human activities, that can be still carried out in Natura 2000 sites, as long as they are managed in a way that does not damage habitats and species for which the site was designated. In particular, art. 6 of dir. Habitat states that all projects that can have an impact on the site must be previously assessed. Transitional water Natura 2000 sites are characterised by the presence of freshwater, brackish and marine waters, and they represent the natural connection between land and sea. They include unique and complex ecosystems, that are highly productive and represent the regulation mechanisms between land and marine processes. Transitional environments are characterised by high variability and affected by a high number of variables (morphological, climatic, chemical-physical). All these factors contribute to give to such environments high spatial and temporal variability. For these reasons, transitional areas are also characterised by high diversity of habitats and species. These areas are important not only from the ecological but also from the socio-economic point of view. Indeed, human activities can exert a significant impact on wetland environments. For this reason, a balance between conservation and development requirements must be found, adopting management policies that follow the principles of a sustainable use of the resources. The need of taking into account both conservation and socio-economic aspects is pointed out by the Water Framework Directive 2000/60/EC as well. Annex IV gives the list of areas included in Natura 2000 network that are relevant also for WFD (see annex 1).

Conflict Management between Conservation and Development Needs

The 8.000 km of Italian coasts are strongly anthropized, but still characterised by high naturalistic values. Since the Sixities, coastal areas have been increasingly affected by urban and industrial development, maritime transports, air and water pollution, irrational use of resources, leading to a significant habitat degradation. Such activities have introduced big amounts of chemicals in the waters, and have caused in many cases long-term environmental contamination.

Many areas are still characterised by critical conditions, that can represent an hazard also for human health. For this reason, interventions aimed at the environmental characterization, reclamation and restoration of polluted sites have often been planned in recent years. Indeed, increasing attention has been devoted to the problems caused by the presence of polluted sites, that are a risk both for the environment and for humans, due to the input of toxic compounds in the soil and underground, and in superficial and underground waters.
A number of legal tools have been developed: L.426/98 defines the Polluted Sites of National Interest (S.I.N.); D.M. 471/99 defines the procedures for pollution emergency response activities (M.I.S.E.) and environmental restoration; D.M. 468/01 defines the National Program of Environmental Restoration of Polluted Sites.
ICRAM (Istituto Centrale per la Ricerca Scientifica e Tecnologica Applicata al Mare) has carried out the environmental characterization of marine-coastal and wetland areas included in SIN borders (Figure 1).
There are 24 coastal-lagoonal SINs dislocated thoroughout the Italian coasts, covering a wide range of ecosystems and characterised by many different types of contamination.

Case Study: Recommendations for Monitoring of M.I.S.E. Activities in the SIN of Orbetello

The Lagoon of Orbetello is located in Tuscany, and it covers a surface of 2.525 ha, with an average water depth of 1 m. It is composed by a system of coastal lakes, connected to the sea only by the channels Fibbia and Nassa. Water exchange is ensured by winds rather than by tidal currents. Freshwater is mainly provided by rain and by a few acquifers. The lagoonal area has a high conservation value. It is designated as SAC and SPA (cod. IT51A0026; D.M. 25 march 2005, all. 3) and as wetland of national interest (cod. IT008) according to the Ramsar Convention (Figure 2). Part of the lagoon is also included in Riserva Naturale Statale di Popolamento Animale della Laguna di Orbetello managed by WWF, which is an important wintering and breeding site for birds.
A portion of the lagoon hosts the industrial structures of the ex-SITOCO factory. Until 1991 such an industry produced chemicals, whose waste products were nitric and solphidric acid. Also, pirite ashes, rich in heavy metals and in As, Pb and Cd, were produced during the production processes. According to law n. 179 of 2002, this area is a Polluted Site of National Interest. The characterization of the site has been carried out by Laguna Azzurra S.r.l and the university of Siena. The results have shown a strong contamination of soils and waters, mainly due to the presence of metals, PCB, oils and dioxines. The pollution is particularly significant, considering the presence of metals (As, Pb, Cu, Cd, Hg e Zn) and PCB, in the lagoonal area in the proximity of the industrial site, and then it decreases moving towards the outer lagoon. Such a critical situation requires the adoption of measures of pollution emergency response (MISE), in order to avoid a contamination of the acquifers and of the rest of the wetland area. The main measures to be adopted are: (i) the permanent physical embankement of all areas at risk; (ii) the removal of all wastes from the areas at risk; (iii) the removal of polluted sediments from the areas at risk.
In addition, scientific monitoring have been carried out during the MISE action, in order to obtain indications for the correct planning of interventions, minimizing the impacts on the environment. Monitoring has been carried out by ICRAM (doc ICRAM # PM-Pr-TO-OR-01.04). All MISE activities planned have been assessed for their impacts according to Dir. 92/43/EC (art. 6 comm. 3), DPR 357/97 and DPR 120/03.

Recommendations and monitoring criteria during the MISE activities in the Polluted Site of National Interest of Orbetello – Area ex Sitoco

A monitoring plan of MISE activities must take into account all environmental modifications that could be caused by MISE interventions themselves. In Orbetello case study, water, sediments, acquatic biocenoses, birds and humans were considered. It is also important to remember that the modification of one of the components

could affect also the other components. Hence, recommendations have been provided to MISE operators, in order to highlight the measures to be taken to ensure the protection of public health and of the environment. Monitoring is aimed at checking the potential physical, chemical and biological effects of MISE on abiotic and biotic components of the lagoonal ecosystem. On these grounds, the following actions were recommended:

• assess the historical series on the characterization of lagoonal environment and on underground waters in the ex Sitoco area;

• carry out investigations on the water column (physical-chemical and ecotoxicological parameters) in order to avoid a degradation of water quality due to MISE activities;

• transplantation of bivalves and polichaetes to be used as bioindicators, to check the bioaccumulation of contaminants;

• carry out taxonomic investigations on macrozoobenthos, in order to determine the potential impact of contaminants on the benthic community;

• monitor the birds present in the area;

• check the efficacy of measures taken in order to minimize the impacts on humans.

Investigations on birds

The studied area is characterized by a high variety of wetland ecosystems, that are used by a lot of waterbird species for resting, wintering and breeding. It is therefore important to minimize the impacts on such a relevant biotic component. Three types of potential impact can be recognized:

a) direct disturbance, caused by the presence of people and machineries in the area of MISE interventions;

b) temporary not availability of habitats during the interventions, although this is difficult to estimate;

c) chemical-physical variations of the lagoonal ecosystems, due to the modifications caused by the interventions.

Most waterbird species present in the area are sensitive to human disturbance due to the positive correlations between biomass, gregarious and cooperative lifestyle and sensitivity to disturbance itself (Blumstein 2006). Disturbance levels are quantified by measuring flight initiation distance or "alertness" responses (Blumstein et al. 2005; Fernandez-Juridic et al. 2001, Laursen et al. 2005). Most waterbirds have flight initiation distances of 20 - 50 m, whereas for passerines such distances are lower than 20 m (Blumstein 2006). The site has a high avifaunistic value, due to the presence of sensitive and/or rare waterbird species. Hence, preliminary ad hoc observation during the breeding season should be carried out. An initial effect could be a decrease of parental care, that would lead to weaker fledgings and higher mortalities. It is important to avoid disturbance especially during the first breeding phases, nest building, incubation and parental care (that is between february and august). Waders, waterfowl and herons that feed in the area are more adapted to human presence, and several species show high behavioural plasticity. The disturbance is particularly low when it is constant, as it becomes a sort of background noise. A number of species stay in the area throughout the year, but decide whether to breed there or not depending on the level of disturbance and on the overall quality of the site. Particular attention should be paid during the breeding migration (March - July 2006), in order to determine the level of habituation of the bird community to human disturbance, and thus to gain indications on the work planning.

Preliminary indications on impacts on birds

A number of information on the bird populations must be collected before starting MISE activities (breeding characteristics, presence and daily rhythms, flight initiation distances and related parameters).

The observations should be carried out for a few years after the end of interventions, in order to define the restoration of a good status.

Recommendations

The heron colony of Isola di Neghelli (Scoccianti et al. 1999, Gariboldi et al. 2004) must be safeguarded. Interventions should in any case be avoided between february and august.

• bird habitat use should be determined before starting the works in the contaminated areas and in buffer zones not-disturbance areas should be created around the sites of intervention.Such areas should be monitored and in case modified throughout the working period

• hunting in the surrounding areas should be stopped during works, so that they can serve as "buffer" zones

• people and machinery used during works should be as stable as possible, in order to allow habituation

• at the end of the works, the area should be requalified in order to enhance the quality of waterbird habitats

• an expert in avian behaviour should be present throughout the works. Behavioural observations should be carried out in a standardized and systematic way during the whole period

• ecotoxicological studies should also be carried out on birds (in particular for PCB and heavy metal contamination) in order to highlight the potential ecological and ecotoxicological effects of interventions (Dell'Omo 2002)

• a proper divulgation of the modalities of MISE interventions and of the actions carried out to minimize the impacts on the different wetland components should also be carried out

Investigations on the water column

Ten monitoring stations have been dislocated in the intervention and in the surrounding areas. Stations have been placed in strategical positions, as indicated in Figure 3.

Water column monitoring implies:

- *the use of CTD sensors, both permanent and mobile, to determine depth, temperature, conducibility, redox potential, pH and dissolved oxygen;*
- *water sampling to determine:*
  - *TSS, TOC, Nitrites, Nitrates, Ortophosphates, Ammonium, Phosphorous and chlorophylle a;*
  - *microbiological parameters;*
  - *chemical parameters (As, Cd, Hg, Pb, Cu, Zn, PCB, Hydrocarbon C≤12 e Hydrocarbon C>12, IPA);*
  - *ecotoxicological essays on at least two target species.*

Monitoring frequencies

- *Pre-operam monitoring:*
  A literature study of the historical series of ecological characteristics of the transitional environments should be carried out (hydrodynamics, variations of turbidity, salinity and temperature, etc) and at least two pre operam monitoring sessions (2/3 months) should be carried out to verify literature data and calibrate the instruments.
- *Monitoring during MISE activities*
  Monitoring should be regularly carried out from the first day of works, in the following way:
  - *Stable in continuum stations (2)*
    Data from the sensors collected twice per week. Water samples:
    - *once per week (4 times per month) to determine suspended matters;*
    - *every two weeks (2 times per month) to determine the other parameters.*
  - *Mobile stations (8)*
    - *once per week (4 times per month) CTD measures and water samples for suspended matters (TSS);*
    - *every two weeks (2 times per month) water samples to determine the other parameters.*

Chemical and ecotoxicological results should be provided immediately (maximum 5 days after sample collection), in order to highlight the presence of environmental anomalies. Monitoring should be carried out throughout the works and for at least a year after finishing.

- *Monitoring during pauses in MISE activities:*
  Water samples should be still collected at monthly intervals, and all parameters checked.

Investigations on bivalves / polichaetes

Most chemicals of industrial origin can be bioaccumulated by the organisms (organic and organic-clorurate compounds and some heavy metals). It is therefore important to check whether such processes occur, in order to avoid the diffusion of contaminants as a consequence of MISE interventions.
Investigations will be carried out on edible species (such as clams) and on species that spend the entire lifecycle in the site. The best bioindicators for these purposes are bivalves (Tapes spp) and Nereis worms, to be transplanted in 4 stations located in the site of interest. Transplantations should be carried out before starting the interventions, observations carried out throughout the works and for a year afterwards.

Investigations on macrobenthos

The impact of contaminants deriving from sediment perturbations during MISE works on the macrobenthic community and on sensitive species is assessed.
Taxonomic investigations and determination of diversity, richness and abundance indexes should be carried out before starting the interventions, observations carried out throughout the works and for a year afterwards.

Recommendations for MISE Interventions

The monitoring plan provides the following recommendations to mitigate pressures and impacts caused by MISE interventions:

- *definition of interventions timetable in order to avoid bird disturbance (works carried out only between august and january).*
- *MISE activities should include:*
  1. *a study of underground waters interested by MISE interventions. It must be verified that a barrier to the aquifer flow does not affect the wetland water conditions;*
  2. *simulation of the possible effects of the interventions in order to assess the impacts;*
  3. *definition of reference environmental conditions for the ensurance of environmental and public health protection, and of modes and times of work interruptions if the conditions are altered;*
  4. *modes of interventions to avoid contamination of areas that have already undergone MISE interventions;*
  5. *the realization of temporary embankements to protect the area during MISE interventions;*
  6. *considering point 4, the coordination of MISE interventions in the most sensitive areas;*
  7. *postponing removal of embankements and barriers from the most sensitive areas until the end of the works in order to avoid contamination;*
  8. *monitoring all environmental components before during and after interventions (water column, biota, birds), to ensure that MISE activities does not produce any further impacts on the site;*
  9. *control of acustic pollution in the MISE and surrounding areas;*
  10. *control of suspended matter in the air during works;*
  11. *suspension of hunting in the surrounding areas;*
  12. *characterization of soil-sediments in the MISE area to verify the effectiveness of interventions.*

Annex 1

Intercalibration process for transitional waters in Italy

The Water Framework Directive WFD 2000/60/EC states that the protection of ecosystems can be effective if the state of waters is maintained or improved, reaching a good ecological state within 2015. The EU has developed a series of common strategies for the implementation of WFD.
The intercalibration process implies the definition, at the community level and for the different water typologies (river, lakes, coastal waters, transitional waters), of a Boundaries Setting Protocol between the classes High-Good and Good-Sufficient of the ecological state of ecosystems. Such a protocol allows the intercalibration of the methods used by the different states, so that monitoring results can be compared at the Paneuropean level. For this reason the EU has determined the GIG (Geographic Intercalibration Groups), that include all States characterised by similar water bodies and belonging to the same Ecoregion. Italy coordinates the group for marine-coastal and for transitional waters, and the Mediterranean ecoregion (Med-GIG).
In october 2004, the Ministry of Environment gave to APAT the coordination of the marine-coastal group, and in february 2005, it gave to ICRAM the coordination of transitional water group.
However, the coordination is very difficult due to the high heterogeneity among States. This has lead to delays in the Intercalibration of methods for transitional water ecological state classification.
The last Med GIG meeting was held in february 2006 (Annex 1 of Minutes of the 3rd Med GIG Meeting) and it has defined the steps to carry out in order to implement WFD in Med ecoregion for transitional waters. These are the keypoints of the Agenda:

1. definition of a group of TW experts with one representative person per Member State. ICRAM is the National Coordination for Italy.
2. discussion of the typological proposal elaborated for TW.
3. organization of a database of hydrogeomorphological characteristics of Med TW.
4. updating and definition of the official register of intercalibration sites.
5. creation of a WG for the organization of pilot actions.

In Italy, ICRAM has asked to the coastal Regions to communicate the name of the Regional Reference Office for monitoring and safeguarding of TW according to ex DIgs 152/99, art. 3. ICRAM, Ministry of the Environment and APAT have recognized the need to develop a series of actions aimed at creating a national reference framework on the state of the art of technical-scientific knowledge on monitoring and classification of TW. ICRAM and APAT have created a form to be filled by the different Regions (sent in november 2005). Such a form is composed by 8 areas (preliminary data, monitoring elements, physical-morphological characteristics, naturalistic characteristics, research and formation activities, management activities, information on pressures, impacts), and it has allowed a first census of TW in Italy, and the acquisition of the Metainformation, that concerns the types of data available. The following step will be to prepare a national database including all the information provided by the forms, in order to implement the intercalibration process.